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ABSTRACT

This compilation of four journal articles (Instructor, September 1980; Science and Children, September 1980; and Science Teacher, September 1980 and March 1981) focuses on volcanoes, particularly Mount St. Helens in Oregon. The first article, "The Earth is Alive!" describes the eruptions of Mount St. Helens, provides basic information on volcanoes, gives instructions for making a model volcano in the classroom, and lists resource materials on volcanoes. The second article, "Volcanoes: Coming Up from Under," provides information about the eruptions of Mount St. Helens in 1980, a discussion on how volcanoes are formed and monitored, a word list associated with volcanoes, and a source for obtaining a volcano poster for which an activity is suggested. The third article, "Beware of the Permanganate Volcano," discusses the hazards associated with permanganate demonstrations of volcanic eruptions. Alternate demonstrations are offered which include the ammonium dichromate reaction to simulate eruption, baking soda and vinegar to demonstrate lava, and punk to illustrate air pollution from volcanic ash and cinders. The fourth article, "Volcanology by Courier: Science in Stamps," provides five activities involving postage stamps picturing volcanoes or related scenes for use in the study of volcanoes. Activity topics include volcanic features, location of volcanoes, examination of land features which look volcanic but are not, and the making of one's own volcano stamp. (EM)

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Compiled by
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Redwood City, California

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Pamela Lawson

TO THE EDUCATIONAL RESOURCES
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The earth is ALIVE!

**The recent eruptions of Mt. St. Helens will have far-reaching
social and economic implications for all of us.**

**Acquaint kids with the facts of this natural catastrophe—with
what happened, how it happened, and how it will affect the future.**

**Robert Sylwester, Jack Mrowka,
Laurene Zaporozhetz**

Five months ago, Mt. St. Helens was a beautiful 9,677-foot symmetrical mountain with a gracefully rounded, snow-covered peak. Although it lacked the size and rugged grandeur of nearby Mt. Rainier, Mt. Adams, and Mt. Hood, it was the favorite mountain of many people who lived in the Pacific northwest because it was so beautiful.

Situated in the Cascade Mountain Range, about 40 miles south of Portland, Oregon, Mt. St. Helens is one of 600 active volcanoes on earth. The mountain hadn't erupted since 1857; so when it began to act up last March, residents of the area weren't sure what to expect.

But they soon found out. On May 18th, persons as far as 200 miles from the mountain were suddenly awakened by a thunderous blast. It was Mt. St. Helens. After 37 quiet years, it had erupted. A force equal to that of six atomic bombs blew off the entire north face of the mountain, and Mt. St. Helens was suddenly 1,277 feet shorter. A spectacular mushroom cloud of volcanic ash and gases shot 12 miles into the air. Then winds swirled the ash eastward where it eventually fell to earth. The thick layer of ash (several inches in many areas) that fell to the ground

seriously disrupted life over a 500-mile area.

Life on and near the mountain was devastated rapidly as rocks fell everywhere, and shock waves and boiling mud rushed down the mountainside at 80 mph. More than 44,000 acres of forest were leveled; and more than 50 people and millions of fish and forest animals were killed, causing long-range disturbance of normal life in the mountain area and in the agricultural areas and cities farther out. Property damage alone was estimated at well over \$2 billion. And that damage toll is just a beginning, for Mt. St. Helens erupted again on June 13th, and all signs indicate it may continue to erupt.

The forecast isn't all gloomy though. There will be benefits from the volcanic activity. The ash layer on the ground will increase soil fertility once it is worked into the earth, and the ash in the air will cause spectacular sunsets. More importantly, the eruptions of Mt. St. Helens have demonstrated that the earth is indeed alive—that an awesome power lies inside it. Studies of the volcano may find that this internal power can be tapped (in the distant future) as an important source of geothermal energy. Also, many uses may be found for the wide variety of minerals deposited by the eruptions.

As you can see, the natural catastrophe

of Mt. St. Helens will have far-reaching social and economic effects. It's important that your students study it, as a natural phenomenon and as an example of an ecological disruption of everyday life. This teaching unit will provide you with the basic information and resources you'll need to develop explanations and activities on volcanoes.

What is a volcano?

Volcanoes are not distributed randomly throughout the earth, but are concentrated in specific regions known as plate boundaries. The earth's surface is comprised of seven major and several minor pieces or plates. These plates fit together like a giant jigsaw puzzle. However, instead of being stable, as a completed jigsaw puzzle is, the earth's plates are constantly moving, as much as six centimeters a year. The plates (1) push over one another (For example, years ago the South American Plate pushed over the Nasca Plate, forming many volcanoes and the Andes Mountains.); (2) pull apart from one another (In 1963, western Iceland pulled away from eastern Iceland, leaving volcanoes and lava to fill in central Iceland.); and (3) bump along one another (The Pacific Plate with Los Angeles sitting on it is moving northwest toward the North American Plate which has San Francisco

continued

VOLCANOES *continued*

on it. The bumping has caused earthquakes along what is called the San Andreas fault.). This last type of movement generates earthquakes much more often than it generates volcanoes.

Although most volcanoes occur along plate boundaries, they may also occur over what are thought to be long-lasting "hot spots" within the earth's interior. As a plate passes over a "hot spot," magma (hot molten rock) burps upward and out onto the earth's surface in a volcanic eruption. The Hawaiian Islands were formed in this manner.

When the very hot magma of any volcano ascends toward the surface of a mountain, it changes nearby ground water to steam and begins to melt the rocks that cover the outside of the mountain. As the rocks melt, their weight decreases; and hence, the pressure on the magma inside the mountain decreases, allowing it to break through the mountain. All these actions lead to chemical and physical changes within the magma that result in the formation of volcanic rocks and gases. This entire process is called an eruption.

The many kinds of volcanic rocks produced during eruptions can be placed in three different groups on the basis of the percentage of silica contained in the rock. The percentage of silica, a material containing silicon dioxide, is related to the viscosity (or the *stickiness*) of the rock material.

Basalt Rock with less than 50 percent silica in it is not very viscous, and can flow very rapidly down the slopes of the volcano. This type of rock is called basalt. It generally takes the form of a lava flow, and appears as a river of molten rock flowing down the slopes. If the basalt is not viscous and flows very rapidly, it solidifies into a smooth ropy lava (pahoehoe). If it is somewhat viscous, it may solidify into burnt cinder or cinderlike lava. Basalt that solidifies under water may resemble a pillow (pillow lava).

Basalt volcanic eruptions tend to be the least violent and spectacular. They usually occur where two plates are pulling apart, such as in Iceland. They can also occur where one plate is passing over a "hot spot," as in Hawaii. The kinds of volcanic landforms that result from basaltic eruptions are low-sloping shield volcanoes (Hawaii) or relatively flat large plateaus (Columbia River Plateau in Oregon and Washington).

Andesite This type of volcanic rock is named after the Andes Mountains of South

America where great quantities of it are located. Mt. St. Helens would be placed in this group. Since Andesite contains 50 to 75 percent silica, it is more viscous than basalt. It also traps more volatile gases, and it moves more slowly on the ground. Its eruptions are more violent than basaltic eruptions. Much of the rock material may be blown into the air during an eruption and then drop back to the earth along the flanks (sides) of the volcano as large blocks or as fine ash. A large amount of magma will also solidify within the crater of this kind of volcano.

Rhyolite Rhyolite, containing more than 75 percent silica, is the most viscous volcanic material and is associated with very violent eruptions. Most rhyolite is ejected into the sky and falls as a blanket of material over a wide area. Other masses of rhyolite push up into the center of the volcano as a large dome.

Labeling volcanic rocks, eruptions, and landforms allows us to make large-scale generalizations about volcanic phenomena. However, a particular volcano may produce basaltic, andesitic, or rhyolite rock, or gradations of them at different times or in different places within the same volcanic complex.

Several other important geomorphic (landforming and modifying) agents are associated with volcanic eruptions. Here are just a few:

Nuees ardentes (glowing clouds) In very violent eruptions, turbulent masses of superheated gases and incandescent solid materials explode from the volcano and flow very rapidly down the slopes, killing all plant and animal life in their paths. The most notorious example of a *nuee ardente* occurred during the eruption of Mt. Pelee, Martinique, in 1902.

Lahars (large mudflows) If much moisture is present at the top of the volcano, either as a lake, or as glaciers as in the case of Mt. St. Helens, the melting water or lake water saturates the slopes of the volcano, turning portions of the slopes into boiling mud that flows down into nearby river valleys. Mt. Rainier has produced 55 major lahars during the last 10,000 years.

Worldwide ashfalls A much more widespread effect of violent volcanic eruptions is the injection of very fine ash into the upper atmosphere from which it eventually falls many miles from the volcano. Sometimes the ash completely circles the earth several times before it falls.

Tsunamis (sea waves) A phenomenon generated by catastrophic volcanic eruptions

near sea coasts is a very large wave called a tsunami. Tsunamis travel outward from coastal volcanoes at great velocities, and they may inundate low-lying coastal communities when they reach a shore. The eruption of Indonesia's Mt. Krakatoa in 1883 caused tsunamis that killed more than 36,000 people.

Make your own Mt. St. Helens

The following three-stage demonstration will give your class a good idea of what happened at Mt. St. Helens. A small group of imaginative pupils might want to undertake this as a project and develop it into a dramatic display.

Other groups of students can (1) develop a bulletin board display of pictures of the first eruption and its aftermath; (2) use the June 2nd *Time* and *Newsweek* magazine accounts to develop and tape record their versions of radio broadcasts of the first reports of the eruption and present their findings in a simulated press conference of scientists; and (4) study and report on the plates that comprise the earth's surface and the different kinds of earthquake/volcanic activity that result from the movements of these plates.

Construction

1. Get a sturdy grocery box (2 ft. x 2 ft. or larger). Cut down the sides so it's about 3 inches high. Then cut a small hole in the center of the base of the box, just large enough to accommodate a bicycle-pump hose.
2. Construct a 9-inch-high tube by taping two toilet-paper cylinders together. Glue tinfoil to the inside of the tube to form a waterproof lining.
3. Out of cardboard, cut a circle whose diameter is just a little smaller than the diameter of the 9-inch tube. Cover the circle with foil and glue the top of a 12-inch-long dowel to the center of the circle. (See diagram.) Now you have a piston for your 9-inch tube.
4. Turn the box over so the bottom becomes the base of the mountain. Use masking tape to attach the 9-inch tube to the base, directly over the hole in the center. Now you are ready to construct the mountain around the tube. Begin by packing newspaper wads around the tube. Hold in place with a few strips of masking tape. Cover this with a layer of paper mache to shape the mountain; and when this has dried, cover that layer with brown clay.

Your volcano should resemble the drawing on this page when completed. (Don't forget to include Spirit Lake at the base of the volcano.) Lightly insert toothpicks into the clay to simulate trees (which will be knocked down by the eruption sequence).

5. On a separate, flat metal surface (such as an inverted metal tray), away from any flammable material, place a small porcelain crucible. Fill the crucible with crystals of ammonium dichromate, and insert a 3-inch magnesium fuse so that it touches the bottom of the container.

6. Now place the base of the mountain on blocks so that it is at least a foot from the floor. (You might have to use boards or sticks to keep the base from buckling.) Place the end of the bicycle pump hose into the hole in the center of the base and secure it with masking tape. (For a more spectacular display, use two bicycle pumps.)

7. Loosely fill the 9-inch tube with dry oatmeal or some other lightweight, light-colored cereal. Lightly tape a paper mache cone on to the mountain so it rises about 2 inches above the constructed mountain. This represents the relative height of the part of the mountain blown off. Sprinkle some of the oats (or flour) on the top parts of the mountain to simulate snow.

Eruption

You are now ready for the three-stage demonstration of the eruption of Mt. St. Helens.

1. Simulate the initial eruption of the mountain and the spreading of the ash by rapidly and vigorously pumping the bicycle pump, blowing out the dry oatmeal.

2. This is the second stage of the eruption; however, because it involves fire and an actual explosion, it cannot be done in the volcano model. It is spectacular enough to be effective at communicating the nature of this second phase to children even without the prop. **CAUTION: This experiment involves fire and explosive material. It should not be performed near any flammable objects. Because of the hazardous nature of the materials involved, we urge that only the teacher perform the demonstration. If you are at all unsure of your ability to perform this experiment safely, do not attempt it.**

After darkening the room, place the porcelain crucible, with the magnesium fuse inserted, on a metal tray in an area free of anything flammable. Make sure the children are standing a number of yards back, and ignite the magnesium fuse with a Bunsen burner or other hot flame. Stand

back with the children and watch the flame shoot upward as green cinders spurt out of the crucible. The smoke and burning of the crystals simulate the colorful display and smell of an erupting volcano.

3. The lava flow comes last in the Mt. St. Helens eruption sequence. Demonstrate this by inserting the piston into the 9-inch cylinder of the volcano so the dowel goes through the hole used by the bicycle pump hose (stage 1). Fill the tube with mud mixed to a consistency that will flow easily, and push up on the dowel from below. The mud will flow out of the top and down the sides of the mountain, much as lava flows—knocking down the toothpick trees, filling Spirit Lake at the base of the mountain, and reshaping the mountain.

Resource Materials

Mainly for Teachers

Encyclopedia Britannica, **DISASTER! WHEN NATURE STRIKES BACK** (1978, Bantam)

Accounts of severe natural catastrophes, including volcanic eruptions.

Peter Francis, **VOLCANOES** (1978, Penguin)

Thorough, up-to-date.

Maurice Lambert, **VOLCANOES** (1979, University of Washington Press)

Highly recommended background information. Excellent bibliography of books, films, periodicals.

National Geographic Society, **POWERS OF NATURE** (1978, National Geographic Society)

Beautifully illustrated. Forty pages on volcanoes.

Cliff Ollier, **VOLCANOES** (1974, M.I.T. Press)

Complete account of the phenomenon. Richard Williams, **THE CASCADES** (1974, Time-Life Books)

Beautifully illustrated book on the Cascade Range. Ten pages on volcanoes.

Mainly for Pupils

Alice Gilbreath, **NATURE'S SQUIRT GUNS, BUBBLE PIPES AND FIREWORKS: GEYSERS, HOT SPRINGS, AND VOLCANOES** (1977, McKay, K-3) Patricia Lauber, **THIS RESTLESS EARTH** (1970, Random, 5-6)

Forces that shape the earth are explained. Includes birth of an island.

Rebecca Marcus, **THE FIRST BOOK OF VOLCANOES AND EARTHQUAKES** (1972, Watts, 4-6)

Causes, effects, ways of studying volcanoes and earthquakes.

Hershell Nixon, **VOLCANOES: NATURE'S FIREWORKS** (1978, Dodd, 2-5)

Characteristics, causes of volcanic movement for different kinds of eruptions.

Barbara Simons, **VOLCANOES: MOUNTAINS OF FIRE** (1976, Raintree, 3-5)

Forces, effects.

Film

FACE OF THE EARTH (National Film Board of Canada, 17 minutes. 1976. Upper elem.)

Exceptionally good photography. Good background on earth formations. □

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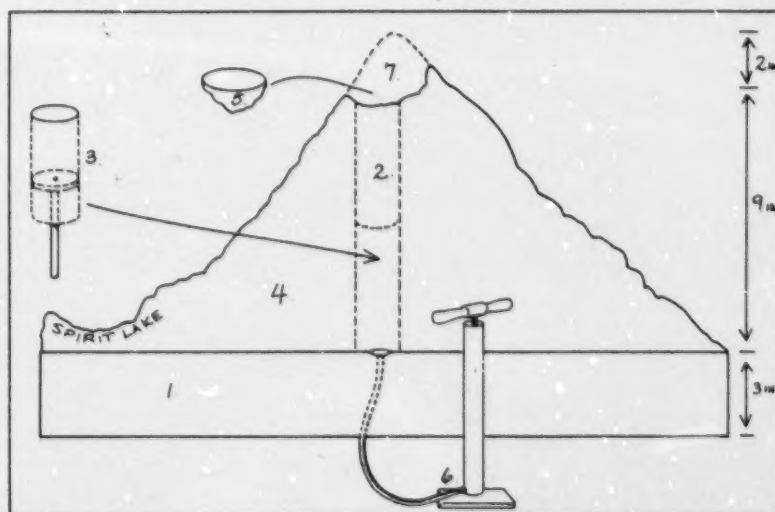


Photo by U.S. Geological Survey

Phyllis Marcuccio

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Volcanoes: Coming Up From Under

When Mt. St. Helens erupted on March 27, it proved what scientists have said for years, "You can't predict a volcano's eruption." Scientists can monitor volcanoes, though the cost of monitoring volcanoes makes it feasible to monitor only a few. Most volcano research has been done on Mauna Loa and Kilanea, nonexplosive volcanoes with highly fluid lava flows on the Hawaiian Islands.

As early as 1975, scientists warned that Mt. St. Helens could erupt before the end of the century. Part of the "Ring of Fire," the circle of volcanoes surrounding the Pacific Ocean, Mt. St. Helens is a composite cone volcano which started forming in 500 B.C. It has been inactive for the past 123 years. St. Helens and other volcanoes in the Cascade range of the Pacific Northwest have a history of violently erupting large amounts of steam, ash, and pumice. Though they have been quiet for several years, volcanoes in the Cascades are potentially dangerous, especially with their proximity to heavily populated areas and large reservoirs.

During St. Helens' recent eruption, there were two phases, one occurring on March 27 and the other on May 18. The May 18 eruption was the more powerful. Accompanying the eruptions were earthquakes, plumes of volcanic ash and steam over 2,000 m in the air. On the summit a crater, 70 to 85 m across, 45 m deep, formed along with two east-trending cracks, one five km long, the other 1.6 km long. The peak area was covered with deformed rock, ice, snow, and a swath of dark volcanic ash bulging steadily upwards and outwards by 90 m. In following days, eruptions,

caused by subsurface water falling through rocks, heating to the boiling point, then expanding violently in bursts of steam, shot ash and gas 5,000 m in the air. The ash was pulverized old rock. Gradually, a second crater formed on the summit. With continual explosions, the two craters merged into a large one 500 m across, 260 m deep, containing all the eruptive vents.

The north peak around the Goat Rocks area developed a bulge after the first eruption. A 1.3 square km area rose 25 m; the top portion rose 90 m during the first month of eruption then grew at a rate of 1.5 m per day. The growing bulge was a result of viscous magma moving up into the volcano. Later, this bulge would release ash and mud flows 60 m deep, going 29 km into the Toutle River valley.

On May 18, Mt. St. Helens erupted again, releasing an energy force equivalent to 10 to 50 megatons of TNT, shooting one cubic km of rock, ash, and steam 15,000 to 18,000 m in the air, and initially blowing ash 96 km east. An accompanying earthquake, measuring 5 on the Richter Scale released a force equivalent to 20 kilotons of energy. The top crater had grown to 1 km wide, 2 km long, and 0.3 km deep. The May 18 eruption was the largest violent eruption in the conterminous 48 states in 130 years. Ash continued to drift eastward across the United States until a cloud passed over the East coast a few days after the eruption. Ash depths ranged from 120 cm around the volcano to 12 cm, 80 km southwest of Spokane, Washington, and to one cm in Oklahoma.

As the ash began to settle, resi-

dents of Washington concentrated on searching for missing persons and cleaning up ash, mud, timber, wrecked homes, and clogged rivers and highways. On May 30, scientists reported lava forming at the bottom of the crater in the floor of St. Helens. Later, scientists reversed their statement, saying no lava had formed. Lava forming would have been a sign of the mountain rebuilding itself.

How Volcanoes Are Formed

Volcanoes are mountains, but unlike regular mountains, they are not formed by layers of the Earth folding, crumpling, uplifting, or eroding. Volcanoes are self-made mountains, formed from a collection of their own products—lava, bombs, ash, and dust. Often a volcano is in the shape of a conical hill with a vent pointing into reservoirs of magma below the Earth's surface. When buoyant magma in the Earth's crust rises to weak surface areas and explodes due to the release of gas pressure, a volcanic eruption takes place. Lava either flows from the vent or shoots into the air with large fragments falling back around the vent while finer particles of dense lava clouds spread for miles around the volcano.

Gas and temperature affect how magma becomes lava and flows from the volcano. When a volcano erupts, the lava is hot, red, and fast moving. As it cools, it becomes darker, changing to dark red, gray, or black. As the lava cools, it becomes thicker, moving slower, more like honey than syrup. Gas helps magma rise through fractures and vents in the volcano. After erupting, gas helps determine the texture and density of the lava flow. If the lava flow is hot, it will be

thinned with gas escaping easily. The lava will bubble down the mountain with minimum explosions. This type of lava has a higher viscosity. If the lava flow is cool, thick, and heavy, the gas will cause explosive eruptions, throwing blocks of rock, lava, dust, and ashes into the air. This type of lava has low viscosity.

As the gas separates from the lava, it creates rock froth called pumice, a light, holey, dark rock. Often, the pumice is broken into volcanic ash, volcanic cinders, and volcanic dust. These small, light fragments are thrown high in dense clouds.

How Volcanoes Are Monitored

Not counting volcanoes under the sea, there are 500 to 600 known active volcanoes in the world. Considering the 200,000 deaths during the last 500 years and the amount of property and natural resources destroyed, watching and trying to predict eruptions are critical.

Monitoring volcanoes begins with a basic understanding of the prehistoric eruptive record and behavior of a volcano. Through regional geophysical and geological studies, dating and geochemical investigations, scientists learn volcanoes' pasts. Once the seismic data is known, scientists record the slope of the volcano for contractions and expansions with electronic-mechanical tiltmeters with field surveying techniques. Changes in horizontal and vertical distances are measured by an instrument using a laser beam. Though it is virtually impossible to predict the exact day of eruption, monitoring volcanoes lets scientists warn populations of increased volcanic activity and of times when there is greater chance of a volcano erupting. Volcanoes in the northwest have erupted only rarely within recorded historic times, making them harder to predict, hence, potentially more dangerous.

Changes in the surface of the Earth can signal scientists to magma moving below the Earth's surface, preparing to rise through vents, cracks, and weak surfaces of the Earth. Swelling of the Earth and earthquakes precede, accompany, and succeed volcanoes. During the first month of St. Helen's eruption, 33 earthquakes ranging from 3.4 to 4.8 on the Richter Scale took place. During the second eruption, May 18, scientists recorded

an earthquake measuring 5 on the Richter Scale.

Between the two St. Helens eruptions, harmonic tremors were recorded. These continuous releases of seismic energy are associated with underground movement of magma. Recent volcanic eruptions in Hawaii have been preceded and accompanied by harmonic tremors.

U.S. Geological Survey



Words Associated with Volcanoes

Cinder Cones—Volcanoes formed through eruption of cinders falling back on the vent forming a crater and cone. Lava flows pour out of the top after excess gas in the magma has escaped below the Earth's surface. The volcano in a farmer's field in Paricutin, Mexico, is an example of a cinder cone.

Composite Cones—Volcanoes within large mountains rising 1,800 to 2,400 m above their bases. They are built of alternating layers of lava flows, volcanic ash, and cinders. Sometimes they are called stratovolcanoes. Mt. St. Helens is a composite cone.

Shield Volcanoes—Short and broad shield volcanoes are built almost entirely of lava flows. From a main vent, or group of vents, flows pour out on top of preceding flows. The result is a broad, gently sloping cone, 4,500 to 6,000 m high and five to six km wide. The Hawaiian Islands are a cluster of shield volcanoes, some of the largest volcanoes in the world. Mauna Loa, Hawaii, is 8,500 m from the ocean bottom to the peak.

Lava Domes—Thick, pasty lava sometimes forms domes in the shape of steep-sided craggy knobs or spines over a volcanic vent. Other domes are short, steep-sided lava flows called

coulees. Mt. Pelee, Martinique, is an example of a lava dome.

Vent—The throat or main shaft from where molten rock and gas rise from the Earth's interior and spue forth into the atmosphere.

Magma—The molten rock that is inside the volcano.

Calderas—Depressions caused by the collapse of volcanoes. Crater Lake, Oregon, is an example.

Active—A volcano that has erupted recently, is currently erupting, and is expected to erupt in the future. Mauna Loa and Mt. St. Helens are active volcanoes.

Dormant—A volcano that shows no recent eruption, but could erupt in the future. Mt. Rainier, Washington, is a dormant volcano.

Extinct—A volcano that has not erupted in recorded historic time and is not expected to in the future. Mt. Mazama, Oregon, home of Crater Lake, is extinct.

Lava—Once the magma pours from the volcano, it is called lava. It is a flow of magma ranging from thin to pasty liquid.

Viscosity—The measurement of how thin a liquid is. A lava flow with high viscosity is thin, flowing down a slope faster than a lava flow with low viscosity.

Tephra—Materials ejected from the volcano that include dust, ash, cinders, pumice, bombs, and blocks.—RW

Volcano Poster

Who says the most volcanic activity this year will be in Washington? Make your own eruptions by using "Volcanoes," the poster at right, to study what happened at Mt. St. Helens and at other volcanoes throughout geologic history. Lisa Baker, designer and artist, and Susan Kaschner-Jagoda, the geologist, researcher, and author collaborated to produce the poster for S&C. Both are from the Lawrence Hall of Science, Berkeley, California.

The front side of the poster explains the stages of St. Helens' eruption. The back side gives examples of different types of volcanoes and their locations throughout the world.

"Volcanoes" is available from NSTA's Publications Division for \$1. Orders less than \$10 must be prepaid and include \$1 for postage and handling. Purchase orders accepted for orders over \$10.

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Beware of the Permanganate Volcano



—Ellie Snyder—

The sixth graders stood a safe distance away and watched eagerly as the teacher prepared the volcano experiment to be demonstrated outdoors on the school playground. The volcano reaction occurred, and after a few seconds the teacher and two students moved toward the metal container. Suddenly, it exploded with great force, spraying acid and other chemicals on the students, burning one in the eyes. The fire marshal confiscated the evidence. Children who were burned were rushed to the hospital. Most were treated and released the same day.

What happened? The teacher had been demonstrating the "permanganate volcano" to his students, undertaking many safety precautions such as having students stay at least six m away; insisting those who were working with the demonstration wear goggles; and being careful that every-

one stood upwind of where the demonstration occurred. The experiment had been conducted many times without incident or injury.

This accident need NOT have happened. Anyone considering this demonstration, which incredibly persists years after chemistry books began warning of the unstable reaction, is taking extreme risks. There are alternative demonstrations involving safer chemicals that will not injure children and their teachers unexpectedly.

The permanganate volcano involves the chemical potassium permanganate (KMnO_4) and sulfuric acid (H_2SO_4) which, when combined in this experiment, form the unstable compound manganese(7) oxide (Mn_2O_7). This reacts with moisture in the air to create a purple fog of permanganic acid (HMnO_4).

Another way teachers have used to demonstrate volcanic eruptions is with an ammonium dichromate reaction. This involves a small quantity of ammonium dichromate crystals ignited on a piece of asbestos. The orange crystals form dark green ash, smoke, and a conical shape. The gas

formed is nitrogen. Nothing explodes; however, the ammonium dichromate reaction is *not* recommended due to the carcinogenic potential of the ammonium dichromate and the chromium compounds formed during the reaction.

Lava flow may be demonstrated in a simple manner. Ordinary baking soda and vinegar, combined in equal portions in the cone of a papier-mâché volcano (or one made of salt, flour, and water), foams out of the crater and down the sides. The experiment can be done indoors.

Another kind of volcano demonstration can be used to illustrate air pollution resulting from the ash and cinders. You can buy punk in variety stores. Cut pieces three cm. long. Tie several pieces together in a bundle and put these in the cone of a homemade volcano. Ignite the punk carefully with a match, and the volcano will begin to smoke just like a real volcano with real poisonous gases which will drift in the direction the wind is blowing. This experiment should always be performed outdoors.

Ellie Snyder is Managing Editor, NSTA Publications Division and former Managing Editor of S&C. Art by Judy Leyshon.

VOLCANOLOGY BY COURIER: SCIENCE in STAMPS

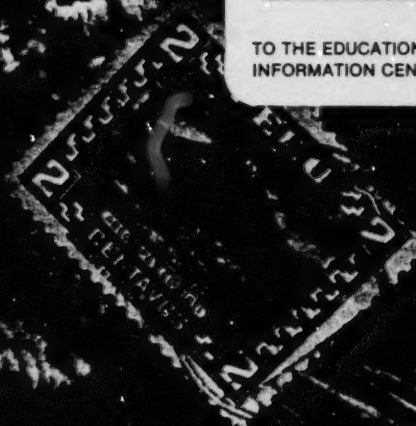


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William H. Glenn

A great many nations have issued postage stamps picturing volcanoes or related scenes. Volcanoes in active eruption, crater lakes in extinct calderas, volcanic rift lines, and geysers are but a few of the features depicted.

The ready availability of many of these stamps and of stamp catalogues picturing them makes it possible to devise highly motivating learning activities, which can be used either during a unit on volcanism or as a summary.

Teachers must keep in mind that the stamps are a means to an end and not an end in themselves. Library research skills should be stressed, and the amount of time spent searching for appropriate stamps limited.

In order to carry out these activities, students should have access to the following:

- A good library.
- The *Scott Standard Postage Stamp Catalogue* (4 volumes), or other illustrated stamp catalogues.
- A detailed world map and/or globe.
- A cooperative stamp-collecting club and stamp dealer to help locate copies of stamps.

Many of the stamps mentioned below are common and may possibly be found in students' personal collections. Others can be obtained from dealers at small cost, particularly if damaged "space fillers" are deemed acceptable for the purpose of these exercises. Though a few expensive items have been included because of their exceptional interest, it is not expected that students should buy or otherwise obtain these; identification of illustrations in the stamp catalogue is sufficient.

Activity I

What kind of volcanic feature is this?

Procedure: Divide the class into two groups, A and B. Each group will

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Stamp of Mayon Volcano, an active stratovolcano in the Philippines.

search available stamp catalogues and collections for stamps illustrating likely volcanic features (see Table 1), and obtain copies of the stamps if possible. (The volcanic features aren't necessarily the most prominent part of the stamp design. For instance, the United States Hudson-Fulton issue of 1909 [Scott, 372] shows the Palisades—an igneous sill—in the background, with ships and the Hudson River in the foreground.) Group A will then study the stamps located by Group B, and vice versa, and attempt to identify the type of feature shown on each stamp. For each stamp, a brief caption describing the illustrated feature can be prepared.

After a class discussion, prepare a mounted display of as many actual stamps as possible, along with their descriptive captions. Leave spaces for unobtained stamps that were identified from the catalogue only. (Caution: To avoid damage to the stamps,

mount them with stamp hinges or other mounts obtained from a stamp dealer. Avoid tape, glue, or paste.)

Background for Activity I:

Volcanic mountains can be classified into three types:

- **Cinder cones:** Steep-sided mountains formed from fragmental debris (pyroclastics) ejected explosively from the volcano. Relatively small amounts of lava are present. Examples are Sunset Crater in Arizona and Parícutin in Mexico.

- **Shield volcanoes:** Gently sloping volcanic mountains formed from successive solidified lava flows. Relatively small amounts of cinder and ash are present. The Hawaiian volcanoes are fine examples.

- **Stratovolcanoes (composite cones):** Volcanic mountains composed of both solidified lava flows and pyroclastic material. Most of the world's volcanoes fall into this category. Examples are Mounts Shasta, St. Helens, and Rainier in the United States.

Several other important volcanic features are:

Eroded volcanic necks. Extinct volcanoes, like other landforms, are subject to erosion. Since the volcanic neck (the interior core of solidified magma) is usually more resistant to erosion than the outer layers of the mountain, the neck remains as a jagged mass rising above the surrounding landscape long after the rest of the mountain is worn away. An example is Shiprock, New

Table 1. Stamps showing types of volcanic features

Country	Scott cat. no.	Feature shown	Comments
Mexico	C235	Parícutin erupting	Typical cinder cone. First erupted in 1943; stopped erupting 1952.
Philippines	354	Mayon Volcano	A stratovolcano (composite cone).
Iceland	247	Mt. Hekla	Considered by some to be a stratovolcano, but by others to be more closely related to shield volcanoes.
	251		
	252		
United States	372	The Palisades (in background)	Cliff composed of a sill of the igneous rock diabase.
	744	Old Faithful Geyser	Geysers are associated with volcanism and hot magma bodies.
	1-53	Crater Lake, Oregon	The crater is actually a caldera. Wizard Island in the lake is a cinder cone.
	745		
	1191	Shiprock, New Mexico	An eroded volcanic neck.

"Teachers must keep in mind that the stamps are a means to an end and not an end in themselves. Library research skills should be stressed. . . ."

Mexico.

Calderas. Some large eruptions result in the collapse of the volcano and the formation of a large pit-like depression, or caldera, a kilometer or more across. A fine example is the caldera that contains Crater Lake, Oregon.

Dikes and sills. Flat masses of molten magma that have intruded into the surrounding rock layers and solidified are called dikes or sills, depending on whether they cut across the rock layers or run parallel to them. Erosion frequently reveals such features to view. An excellent example of a sill of igneous rock is the Palisades along the Hudson River at New York City.

Activity II

Where are volcanoes found?

Procedure: On a large oak tag sheet have the students prepare a map of the world indicating the major zones of volcanism and the names of countries and islands associated with these zones. Then have a group of students locate stamps illustrating volcanic features from countries along the zones of volcanism. (See Table 2.) Any stamps obtained can be mounted on the map; spaces may be left for unobtained stamps. For each volcanic feature, students should prepare a written description providing as much information as possible about it. As an alternative to one map of the world, separate maps may be made for each major zone of volcanism, for example, the circum-Pacific "ring of fire," or the Mid-Atlantic Ridge.

Background for Activity II:

Most volcanoes are located in specific zones. One great zone, the circum-Pacific belt, or "ring of fire,"

Table 2. Stamps showing volcanic features in countries along zones of volcanism

Country	Scott cat. no.	Feature shown	Comments
MID-ATLANTIC RIDGE			
Iceland	372-374	Emergence of Surtsey Island, 1964	New island formed by marine volcanic eruption.
	476-477	Volcanic eruption on Heimaey, 1973	Volcano Eldfell destroyed 200 homes on Heimaey, off coast of Iceland.
Ascension	43	Green Mountain	Green Mountain is a large elliptical crater.
	230-234	Volcanic terrain	Five stamps printed se-tenant to show panorama of volcanic terrain.
Tristan da Cunha	20	View of Tristan	Typical shape of a volcanic peak.
ALPINE-HIMALAYAN BELT			
Italy	882	Stylized view of Bay of Naples and Vesuvius	
Greece	706	Santorini	The island group of Santorini (Thera) has a deep submerged caldera at its center, formed in a great eruption about 1500 BC.
	1206		
Armenia	293-294	Mt. Ararat	Dormant volcano, traditional resting place of Noah's Ark.
Iran	C68	Mt. Demavend	Dormant volcano.
Indonesia	B69-B76	Merapi erupting, 1954	Elevation 2,912 m. Erupts about every five years.
CIRCUM-PACIFIC BELT			
Japan	460-463	Views of Fujiyama	A stratovolcano.
	758	Sakurajima Volcano erupting.	Great eruption in 1914.
Philippines	354	Mayon Volcano	Active stratovolcano. Noted for its symmetrical shape.
	508		
British Solomon Islands	76	Tinakula Volcano, Santa Cruz Islands	
French Polynesia	173-175	Island of Borabora	Partially submerged volcanic island.
New Zealand	399	Mt. Ngauruhoe	Only active volcano in New Zealand.
	400		
	403	Pohutu Geyser	Geysers are found in New Zealand and Iceland as well as in Yellowstone.
Ross Dependency (New Zealand)	L1 L5	Mt. Erebus	Active volcano in Antarctica.
Chile	206	Osorno Volcano	Last eruption 1850.
Ecuador	407-407C	Mt. Chimborazo	Dormant or extinct. One of the highest Andes volcanoes, 6248 m.
	C291	Cotopaxi Volcano	Highest active volcano on Earth, 5959 m.
Nicaragua	121-133	Momotombo Volcano	Active volcano on peninsula in Lake Managua.
El Salvador	559	Izalco Volcano	The "Beacon of Central America," one of the most active volcanoes on Earth.
Mexico	302	Popocatepetl	Old volcano but still active.
	C67	Orizaba Volcano	Last erupted in 18th century.

(Table 2 cont.)

United States	742	Mt. Ranier	Dormant stratovolcano.
	1124	Mt. Hood (in background)	Dormant stratovolcano.
CARIBBEAN REGION			
Martinique	226-228	Mt. Pelée	Great eruption of 1902 killed 30,000. Destroyed city of St. Pierre.
St. Vincent	515-517	Map of St. Vincent	Try to locate La Soufrière Volcano on map. Eruption of 1902 occurred just before that of Mt. Pelée.
Guadeloupe	63-78	La Soufrière	Same name as on St. Vincent; different volcano.
AFRICAN RIFT ZONE			
Kenya, Uganda, and Tanzania	66	Mt. Kilimanjaro	Extinct volcano. Highest mountain in Africa.
	71		
	97		
	182	Mt. Kenya	Extinct or dormant volcano. Elevation, 5,194 m.

Table 3. Stamps in which relationship to volcanism is not obvious

Country	Scott cat. no.	Feature shown	Comments
United States	C46	Diamond Head, Hawaii	An eroded volcanic crater.
	929	Marines raising flag on Mt. Suribachi, Iwo Jima	Mt. Suribachi is a volcano.
	1009	Grand Coulee Dam	The dam blocks a valley cut through the Columbia Plateau, a lava plateau.
Greece	698	Knossus	Knossus was the main center of the Minoan civilization on Crete. The eruption of Santorini about 1500 BC may have led to the downfall of Minoan civilization.
British Indian Ocean Territory	34	Aldabra Atoll	Classic atoll shape, composed of coral reefs atop submerged volcanic peak.
	82		
Tristan da Cunha	55-67	Stamps of St. Helena overprinted "Tristan da Cunha Resettlement 1963"	The 1961 eruption caused evacuation of the entire population to England. They returned in 1963.
Martinique	74-92	Fort de France	The city that did not get destroyed in the 1902 eruption of Mt. Pelée. The ruined St. Pierre is not shown on any stamp.

Table 4. Some non-volcanic stamps

Country	Scott cat. no.	Feature shown	Comments
United States	747	Great White Throne, Zion National Park	Eroded sandstone mass.
	748	Mt. Sinopah, Glacier National Park	Glacially eroded horn peak, composed of metamorphic rock.
Brazil	112-115	Sugarloaf Mountain	Erosional remnant of granite gneiss, Rio de Janeiro.
Gibraltar	108	Rock of Gibraltar	Composed of limestone.

"A game can be devised in which one group of students attempts to locate stamps illustrating scenes related to volcanic activity, but not obviously so."

extends completely around the Pacific Ocean basin, from the Kamchatka Peninsula of Siberia, through Japan, the Philippines, Melanesia, New Zealand, parts of Antarctica, the Andes of South America, Central America and the Caribbean, western North America, and the Aleutian Islands. A second belt of recent mountain building which contains active volcanoes is the Alpine-Himalayan belt, from the Canary Islands, through the Mediterranean region, and eastward across southern Asia to include Indonesia. The Mid-Atlantic Ridge is marked by a line of volcanic islands extending from Iceland in the north to Tristan da Cunha in the south. Other volcanoes are associated with the rift valleys of Africa. The Hawaiian Islands appear as an isolated group, as do some other islands in the Pacific and Indian Oceans.

Activity III

How is this scene related to volcanism?

Procedure: Many illustrations have a relationship to volcanism that is not immediately obvious (see Table 3). For example, a stamp issued by or illustrating a Pacific Ocean atoll requires students to understand that atolls are coral reefs surmounting submerged volcanic peaks.

A game can be devised in which one group of students attempts to locate stamps illustrating scenes related to volcanic activity, but not obviously so. A second group then attempts to identify the scenes and relate them to volcanism. The second group scores if its members correctly relate the feature to volcanism. The first group scores if the second misses, and Group I can provide the correct response. But the first group

"Earth science can be integrated with art by having students locate photographs or other illustrations of volcanic features . . . and then design their own stamps. . ."



Stamp of Fujiyama, Japan, a dormant stratovolcano.

Table 5. Suggested volcanic features for student "stamp artists"

<i>Feature</i>	<i>Location</i>	<i>Comments</i>
Giant's Causeway	Northern Ireland	Basalt flows, showing hexagonal jointing.
Craters of the Moon National Monument	Idaho	Cinder cones and lava flows.
Mauna Loa	Hawaii	Classic shield volcano.
Mt. Etna	Sicily	Active stratovolcano.
Mt. Shasta	California	Dormant or extinct stratovolcano.

loses points if its selection is challenged and proves to be irrelevant to volcanism.

trip up the opposite group. A good deal of library research will be needed here.

Activity IV

We're not volcanic!

Procedure: Some landforms, especially erosional remnants and isolated mountain masses, may appear to be volcanic at first glance, but turn out not to be (see Table 4). In this exercise, one group of students should locate stamps illustrating features that look as if they are volcanic, and a second group should decide whether or not they are. The aim should be to

Activity V

Let's make a stamp.

Procedure: Not all famous volcanoes are portrayed on stamps, nor do all countries illustrate their volcanoes on stamps (see Table 5). Earth science can be integrated with art by having students locate photographs or other illustrations of volcanic features they feel are worthy of portrayal, and then design their own stamps using as much artistic license as necessary. ■